

# **Engineering Microsystems: “XYZ on a Chip”**

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***Program Solicitation  
NSF 99-31***

**DIRECTORATE FOR ENGINEERING**

***Pre-Proposal Deadline:  
February 5, 1999, 5:00 pm (local time)***

***Proposal Deadline:  
June 4, 1999, 5:00 pm (local time)***



# NATIONAL SCIENCE FOUNDATION

## INTRODUCTION

The Engineering Directorate of the National Science Foundation (NSF) announces a research initiative on Engineering Microsystems: "XYZ on a Chip." The focus is on non-electronic applications that make effective use of the fundamental aspects of the technology of microelectronics by adding new functions, processes, or capabilities. The initiative is intended to encourage development of novel applications, exploration of non-electrical processes at micro-scale, extension of lithographic "printing" methods to non-electrical processes, architectural and design issues of "wet" chips that interface to biological or chemical processes, materials and layering problems, and rapid prototyping. The initiative has a strong emphasis on non-traditional applications. Proposals are encouraged to integrate electronics with non-electronic processes to enhance functions and capabilities, but the processing of electrical signals in itself is not a focus of this initiative. The initiative will encourage cooperative and interdisciplinary activities, as well as the use of shared facilities and access to federally supported laboratories and resources to undertake any experimental and computational phases of the proposed research. Researchers are encouraged to visit the ENG web-site ([www.eng.nsf.gov/programs/nsf99-31.htm](http://www.eng.nsf.gov/programs/nsf99-31.htm)) for any update on this initiative.

## BACKGROUND

The invention of transistors, quickly followed within a decade by integrated circuits, created the world of microelectronics and ushered in a second industrial revolution based on an intense exploitation of knowledge and information. The remarkable feat of microelectronics is not the reduction in size, in itself, but rather an elegant solution to the problem of complexity. As the size of individual components shrinks, and the number of components in a system increases, their interconnection grows geometrically more complex. Integrated circuit technologies have solved this problem by careful attention to the modularity, hierarchy, and interconnections imposed in the chip *design* discipline. The subsequent manufacturing process exploits this organization through the standardization of fabrication steps. The technology of microelectronics that has evolved is one of great power and sophistication and can now be extended to applications other than electronics. It is useful to call this the "chip technology." The extension of this technology to

include non-electronic devices, processes, and mechanisms leads to the terminology “XYZ on a chip,” where XYZ may refer to any non-electrical phenomena such as biology, genomics, chemistry, optics, mechanics (including microelectromechanical systems, or MEMS), sensors, actuators, and software.

## **PROGRAM DESCRIPTION**

The evolution of microelectronics chip technology has created opportunities to develop new types of microsystems based on physical, chemical, and biological principles. This initiative is designed to support fundamental research that will enable the development of advanced engineering microsystems involving non-electrical processes and their integration with electronics. Proposals in support of the following themes are invited:

1. investigation of non-electrical *processes and relevant properties* at micro and nano scales,
2. development of *architectures, physical representations, and design methodologies* for non-electrical processes and micro-systems,
3. development of *fabrication* techniques for biological, chemical, optical, mechanical and other processes,
4. rapid *prototyping* techniques for novel chips,
5. *interfacing and integrating* of non-electrical processes with electronics and with each other.

Proposed research projects should substantially contribute to one or more of these basic research themes of engineering microsystems and address the *integration* of these themes in the context of specific environments and applications. Although the primary emphasis will be on achieving a high degree of fundamental understanding, any investigation of potential impact on new applications will also be given a high priority. Experimental testing and evaluation of prototype systems is encouraged. It is anticipated that cooperation among researchers from different disciplines will open new avenues of research and develop new applications. Each research proposal should identify areas of application and potential impacts.

## **ELIGIBILITY**

U.S. academic institutions are eligible to submit pre-proposals and full proposals. Research may be proposed by individual investigators or by small groups from academic institutions. Synergistic collaboration among researchers and collaboration or partnerships with industry or government laboratories are encouraged when appropriate. Proposals involving more than one institution must be submitted as a single administration package from one of the academic institutions involved. Prospective applicants are encouraged to contact one of the program officers listed in this document for additional guidance on collaborations.

Pre-proposals are mandatory and must be submitted by academic institutions  
Full proposals submitted in response to this solicitation will only be accepted by NSF if they are invited by NSF based on review and recommendation of the pre-proposal submissions.

## **AWARD INFORMATION**

Under this solicitation, NSF solicits proposals for funding amounts in the range of \$100,000 to \$300,000 per year for up to three years, and expects to make grants at a variety of award sizes appropriate to the technical scope and level of effort required. NSF expects to fund approximately 20 to 25 research awards depending on the quality of submissions and the availability of funds. NSF funding for this solicitation in FY 1999 is budgeted at approximately \$10 million.

## **INSTRUCTIONS FOR PROPOSAL SUBMISSION**

### **A. Notice of Intent**

To assist NSF to develop an appropriate reviewer base before pre-proposals are submitted, Principal Investigators intending to submit a pre-proposal are encouraged to submit a notice of intent via email to: [xyzintent@nsf.gov](mailto:xyzintent@nsf.gov) by December 16, 1998. The notice of intent is not mandatory. P.I.s who do not submit this notice may submit pre-proposals. The notice of intent should include: title of proposal, the names and affiliations of the Principal Investigator and any co-Investigators, including those from industry or national laboratories, and a brief three to five sentence description of the proposed work.

### **B. Pre-Proposal Submission Instructions**

A pre-proposal is required for response to this Solicitation. Each pre-proposal should consist of the two page NSF cover sheet, a project description of not more than three (3) pages (single space, minimum 10 point type) that includes a description of the goals, background, approach, expected outcomes of the proposed research and list of expected collaborators. In addition to these three pages, a biographical sketch for the Principal Investigator should be included.

Pre-proposals are required to be submitted electronically via FastLane (<http://www.fastlane.nsf.gov>). Important instructions for preparing FastLane proposals are included in this solicitation as Appendix 1. Detailed Instructions for Preparing and Submitting Proposals via FastLane are located at <http://www.fastlane.nsf.gov/a1/newstan.htm>. For further information about FastLane, contact FastLane user-support services (tel: 703-306-1142; [fastlane@nsf.gov](mailto:fastlane@nsf.gov)).

There will be a number of error messages in the submission of the pre-proposal related to missing forms – these can be ignored by the PI. Only the cover sheet, project description and biosketch described above are to be submitted.

Pre-Proposals must reference this program solicitation (NSF 99-31) on the cover page. For EPSCoR-certified pre-proposals, write EPSCoR only on the top right corner of the signed original. Page limitation guidelines must be strictly adhered to. No appendices to a pre-proposal are permitted, and pre-proposals submitted with appendices will not be reviewed.

### **C. Final Proposal Preparation Instructions**

Only invited proposals, selected on the basis of review of pre-proposals, will be considered by NSF for this competition. Invited proposals must conform to NSF proposal-submission

requirements, following general guidelines contained in the NSF Grant Proposal Guide (*GPG*, NSF 99-2). The complete text of the *GPG* (including electronic forms) is available electronically on the NSF Web site at: <<http://www.nsf.gov/>>. The necessary forms are available in the *GPG* and in the Proposal Forms Kit (NSF 99-3), which is available on the Web at <<http://www.nsf.gov/cgi-bin/getpub?nsf993>>. Paper copies of the *GPG* may be obtained from the NSF Publications Clearinghouse, telephone 301-947-2722 or by e-mail from [pubs@nsf.gov](mailto:pubs@nsf.gov).

Page limitation guidelines will be strictly adhered to. No appendices to the proposal are permitted, and proposals submitted with appendices will be returned without review.

Invited proposals must be fully prepared for electronic submission using the NSF FastLane system. Important instructions for preparing FastLane proposals are included in this solicitation as Appendix 1. Detailed Instructions for Preparing and Submitting Proposals via FastLane are located at <http://www.fastlane.nsf.gov/a1/newstan.htm>. For further information about FastLane, contact FastLane user-support services (telephone 703-306-1142 or by e-mail at [fastlane@nsf.gov](mailto:fastlane@nsf.gov)).

Proposers are reminded to identify the program solicitation number (NSF 99-31) in the program solicitation/solicitation block on the NSF Form 1207, "Cover Sheet for Proposal to the National Science Foundation." Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.

The proposal must also identify the pre-proposal number assigned by NSF in the appropriate box on the Cover Sheet of the proposal. For EPSCoR-certified proposals, write EPSCoR only on the top right corner of the signed original.

### **C. Due Dates**

Notice of Intent to submit a pre-proposal is to be submitted by email to: [xyzintent@nsf.gov](mailto:xyzintent@nsf.gov) by December 16, 1998.

Pre-proposals are required to be submitted electronically via FastLane, and submission of pre-proposals must be completed no later than 5:00 PM (local time) on February 5, 1999. The signed cover sheet (NSF Form 1207) for the pre-proposal should be forwarded to the following address and received by NSF by Feb 12, 1999.

National Science Foundation  
DIS-FastLane Cover Sheet  
4201 Wilson Boulevard  
Arlington, VA 22230

A pre-proposal may not be processed until the complete proposal (including signed cover sheet) has been received by NSF.

Pre-proposal review will be completed by March 5, 1999. Selected pre-proposals will be identified and their Principal Investigators will be invited to submit full proposals in response to the Program Solicitation.

FastLane electronic submission of invited full proposals must be completed no later than 5:00 PM (local time) on June 4, 1999. Proposals are required to be submitted electronically via FastLane. The signed cover sheet (NSF Form 1207) for a full proposal, and paper copies of any supplemental documentation, such as Letters of Support from collaborating industry, should be forwarded to the following address and received by NSF by June 11, 1999.

National Science Foundation  
DIS-FastLane Cover Sheet  
4201 Wilson Boulevard  
Arlington, VA 22230

A proposal may not be processed until the complete proposal (including signed cover sheet) has been received by NSF.

## **PROPOSAL MERIT REVIEW**

### **A. Review of Pre-Proposals**

Evaluation of pre-proposals will be guided by the NSF merit review criteria (see Appendix 2). Pre-proposal review will be coordinated by a working group of NSF program officers. The selection process will involve a panel review to determine intrinsic merit and broad impact related to the specific technical scope of the Engineering Microsystems program goals. Pre-proposals with limited scientific breadth, with single discipline emphasis or impact, or without focus on novel non-electronic implementations and applications will not be reviewed. P.I.s of selected pre-proposals will be contacted by March 5, 1999, and invited to submit a full proposal in response to this Program Solicitation.

### **B. Review of Full Proposals**

Invited full proposals will be evaluated in accordance with the NSF merit review criteria (see Appendix 2) and the additional criteria listed below. Proposal review will be coordinated by a working group of NSF program officers. The selection process will involve a panel review to determine intrinsic merit and broad impact. Additional ad-hoc mail reviews may be used as well.

Additional criteria in the evaluation process specific to Microsystems Engineering: XYZ on a Chip will focus on: a) the contribution of the research on novel, non-electronic processes and functions which are integrated into microsystems chip design and fabrication, b) the contribution to the fundamental science and engineering principles underlying architectures, physical representations, prototyping methodologies and the interfacing /integration of non-electrical processes and electronics, c) a detailed plan for cooperation and implementation which takes advantage of complementary technical strengths, facilities, national laboratories, centers, and/or industry partners.

## **GRANT AWARD AND ADMINISTRATION INFORMATION**

Grants awarded as a result of this solicitation will be administered in accordance with the terms and conditions of NSF GC-1, "Grant General Conditions," or FDP-III, "Federal Demonstration Partnership (FDP) General Terms and Conditions," depending on the grantee organization. More

comprehensive information is contained in the NSF Grant Policy Manual (NSF 95-26), available on the NSF Web site at <http://www.nsf.gov/bfa/cpo/gpm95/start.htm>.

Upon completion of the project, a Final Project Report is required (see GPG, Section VII.G). In addition to providing information for NSF staff review and monitoring of the career-development progress of individual awardees, this information will be used in program evaluation and assessment. Supplementary information for this purpose may be requested from time to time.

## **CONTACTS FOR ADDITIONAL INFORMATION**

Questions concerning this joint program should be addressed, preferably via e-mail, to the following NSF program officers in the Directorate for Engineering:

### Engineering Microsystems Working Group:

Division of Bioengineering and Environmental Systems (BES)

Dr. Janice Jenkins ([jmjenkin@nsf.gov](mailto:jmjenkin@nsf.gov))

Division of Civil and Mechanical Systems (CMS)

Dr. Alison Flatau ([aflatau@nsf.gov](mailto:aflatau@nsf.gov))

Division of Chemical and Transport Systems (CTS)

Dr. Geoffrey Prentice ([gprentice@nsf.gov](mailto:gprentice@nsf.gov))

Division of Design, Manufacture and Industrial Innovation (DMII)

Dr. Delcie Durham ([ddurham@nsf.gov](mailto:ddurham@nsf.gov))

Division of Engineering Education and Centers (EEC)

Dr. Cheryl Cathey ([ccathey@nsf.gov](mailto:ccathey@nsf.gov)) or Dr. John Hurt ([jhurt@nsf.gov](mailto:jhurt@nsf.gov))

Division of Electrical and Communications Systems (ECS)

Dr. Rajinder Khosla ([rkhosla@nsf.gov](mailto:rkhosla@nsf.gov))

## **RELATED NSF PROGRAMS**

Support of collaborations between university and industrial researchers in this program may also utilize the mechanism of the GOALI Program (Grants Opportunities for Academic Liaison with Industry, NSF 97-116, <http://www.nsf.gov/goali>). Projects which have direct involvement of small businesses may instead wish to submit proposals to the Small Business Innovative Research Program (<http://www.nsf.gov/eng/dmii/sbir>).

## **APPENDIX 1: Instructions for Submission of Proposals Using NSF FastLane**

The NSF FastLane system is available for electronic preparation and submission of a proposal through the Web at the FastLane Web site at <http://www.fastlane.gov>. The Sponsored Research Office (SRO or equivalent) must provide a FastLane Personal Identification Number (PIN) to each Principal Investigator (PI) to gain access to the FastLane “Proposal Preparation” application. PIs that have not submitted a proposal to NSF in the past must contact their SRO to be added to the NSF PI database. This should be done as soon as the decision to prepare a proposal is made.

In order to use NSF FastLane to prepare and submit a proposal, the following are required:

Browser (must support multiple buttons and file upload)

- Netscape 3.0 or greater
- Microsoft Internet Explorer 4.01 or greater

PDF Reader (needed to view/print forms)

- Adobe Reader 3.0 or greater

PDF Generator (needed to create project description)

- Adobe Acrobat 3.01 or greater
- Aladdin Ghostscript 5.10 or greater

A list of registered institutions and FastLane registration form are located on the FastLane Web page.

## **APPENDIX 2: Merit Review Criteria**

The National Science Board approved revised criteria for evaluating proposals submitted to NSF at its meeting on March 28, 1997 (NSB97-72). The revised criteria are designed to be useful and relevant across NSF's many different programs. However, NSF will continue to employ special criteria as required to highlight the specific objectives of certain programs and activities.

The revised merit review criteria are listed below. Following each criterion are potential considerations that the reviewer may employ in the evaluation. These are suggestions and not all will apply to any given proposal. Each reviewer will address only those that are relevant to the proposal and for which he/she is qualified to make judgments.

### What is the intellectual merit and quality of the proposed activity?

How important is the proposed activity to advancing knowledge and understanding within its own field and across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of prior work.) To what extent does the proposed activity suggest and explore creative and original concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

### What are the broader impacts of the proposed activity?

How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

In addressing the general NSF merit review criteria, additional consideration will be given to the following in the review process:

#### Integration of Research and Education

One of the principal strategies in support of NSF's goals is to foster integration of research and education through the programs, projects and activities it supports at academic and research institutions. These institutions provide abundant opportunities where individuals may concurrently assume responsibilities as researchers, educators, and students and where all can engage in joint efforts that infuse education with the excitement of discovery and enrich research through the diversity of learner perspectives. PIs should address this issue in their proposal to provide reviewers with the information necessary to respond fully to both NSF merit review criteria. NSF staff will give it careful consideration in making funding decisions.

#### Integrating Diversity into NSF Program, Projects, and Activities

Broadening opportunities and enabling the participation of all citizens – women and men, underrepresented minorities, and persons with disabilities – is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports. PIs should address this issue in their proposal to provide reviewers with the information necessary to respond fully to both NSF merit review criteria. NSF staff will give it careful consideration in making funding decisions.

### **ABOUT THE NATIONAL SCIENCE FOUNDATION**

The National Science Foundation (NSF) funds research and education in most fields of science and engineering. Grantees are wholly responsible for conducting their project activities and preparing the results for publication. Thus, the Foundation does not assume responsibility for such findings or their interpretation.

NSF welcomes proposals from all qualified scientists, engineers and educators. The Foundation strongly encourages women, minorities, and persons with disabilities to compete fully in its programs. In accordance with federal statutes, regulations, and NSF policies, no person on grounds of race, color, age, sex, national origin, or disability shall be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving financial assistance from NSF (unless otherwise specified in the eligibility requirements for a particular program).

Facilitation Awards for Scientists and Engineers with Disabilities (FASSED) provide funding for special assistance or equipment to enable persons with disabilities (investigators and other staff, including student research assistants) to work on NSF-supported projects. See the program solicitation or contact the program coordinator at (703) 306-1636.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation regarding NSF programs, employment, or general information. TDD may be accessed at (703) 306-0090 or through FIRS on 1-800-877-8339.

### **PRIVACY ACT AND PUBLIC BURDEN STATEMENTS**

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the review process; to applicant institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies needing information as part of the review process or in order to coordinate programs; and to another Federal agency, court or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records," 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records," 63 Federal Register 268 (January 5, 1998). Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding this burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to: Reports Clearance Officer; Information Dissemination Branch, DAS; National Science Foundation; Arlington, VA 22230.

### **YEAR 2000 REMINDER**

In accordance with Important Notice No. 120 dated June 27, 1997, Subject: Year 2000 Computer Problem, NSF awardees are reminded of their responsibility to take appropriate actions to ensure that the NSF activity being supported is not adversely affected by the Year 2000 problem. Potentially affected items include: computer systems, databases, and equipment. The National Science Foundation should be notified if an awardee concludes that the Year 2000 will have a significant impact on its ability to carry out an NSF funded activity. Information concerning Year 2000 activities can be found on the NSF web site at <http://www.nsf.gov/oirm/y2k/start.htm>.

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